Water Standards and Studies Report 88-1

Bibliography of Water Standards and Studies Section Publications 1987

By D.J. Brown

Manitoba
Environment and
Workplace Safety
and Health

BIBLIOGRAPHY
OF
WATER STANDARDS AND STUDIES SECTION
PUBLICATIONS
1987

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WATER STANDARDS AND STUDIES, REPORT #88-1

SUMMARY

Brown, D. J. 1988. Bibliography of Water Standards and Studies Section Publications, 1987. Environmental Management Division. Water Standards and Studies Report #88-1. 14pp.

The Water Standards and Studies Section, Environmental Management Services Branch, Manitoba Environment and Workplace Safety and Health produced seven manuscript reports, one refereed journal paper, two papers published in Prcceedings and made an additional four presentations.

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INTRODUCTION

The reports listed in this document were prepared by staff of the Water Standards and Studies Section, Environmental Management Services Branch of the Manitoba Department of Environment and Workplace Safety and Health. Each report was distributed by the Department as it became available. Enquiries for copies should be directed to the following:

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MANUSCRIPT REPORTS

REPORT 87-1 Brown, D. J. 1987. Bibliography of Water Standards and Studies Section Publications, 1986. Environmental Management Services Branch. Water Standards and Studies. 21 pp.

SUMMARY

The Water Standards and Studies Section, Environmental Management Services Branch, Manitoba Department of Environment and Workplace Safety and Health produced eleven manuscript reports, one special report, and twelve miscellaneous reports and presentations during 1986.

REPORT 87-2 Beck, A. E. 1987. Persistence of Glyphosate residues in northern Manitoba ponds. Environmental Management Services Branch. Water Standards and Studies. 41 pp.

SUMMARY

Manfor Ltd. is currently investigating the efficacy of the herbicide Roundup(R) for selective control of competition in conifer plantations. Glyphosate is the active ingredient in Roundup(R) and aminomethylphosphonic acid (AMPA) is its major metabolite. Monitoring of initial Manfor Ltd. field trials in 1985 had suggested that glyphosate and AMPA residues dissipated from surface waters at a rate much faster than had been typically reported in the literature. Because initial results were based on observations of a single water body, there was uncertainty regarding generic applicability of the local observations and, conversely, the applicability of degradation mechanisms reported in the literature. Accordingly, the purpose of the present study was to accurately determine the rate of glyphosate dissipation from water under northern Manitoba conditions. Additionally, the major local mechanism for removal from the water column was to be identified.

A series of six artificial pools was placed in staggered formation at the centre of the 1986 Manfor Ltd. experimental spray block. The spray block was located approximately 63 kilometres north of The Pas in north-western Manitoba. Three pools

contained only water and three contained water and sediments. The pools were calibrated for volume and were each sampled seven times within a thirty-day period after herbicide application. Three sampling sites in a nearby natural pond were treated in a similar fashion and provided a comparison to the natural state.

The study confirmed that the presence of sediments was essential for rapid removal of glyphosate from water in northern Manitoba. Glyphosate residues were found to dissipate rapidly from water when sediments were present; 50% of the initial concentration dissipated within approximately 22 hours of application. Maximum AMPA residues encountered in the water were 2.2% of the glyphosate applied. AMPA residues also dissipated rapidly from the water when sediments were present. AMPA dissipation to 1% of applied glyphosate was predicted within approximately 3.9 days of initial herbicide application. Glyphosate residues were comparatively persistent in sediments as evidence of dissipation was not detected during the thirty-day term of the study period.

REPORT 87-3 Goldsborough, L. G. and D. J. Brown. 1987. Effects of aerial spraying of forestry herbicides on aquatic ecosystems. Part III. Bioassay of the effect of glyphosate on carbon fixation by intact periphyton communities. Environmental Management Services Branch. Water Standards and Studies. 27pp.

SUMMARY

As part of a three-year study examining potential effects of herbicide use in forest management on adjacent aquatic ecosystems, artificial substrata (acrylic rods) were positioned in shallow water within six experimental study ponds near Pine Falls (90° 10'W, 50° 37'N) during late summer. The substrata were permitted to colonize with periphytic algae for a period of 41 to 50 days, after which samples were collected and exposed in the laboratory to concentrations of glyphosate (added as the commercial formulation Roundup) ranging from 0 to 1800 mg/L. Carbon fixation rates during the first four hours after herbicide treatment were measured, and the change in rate relative to untreated controls was used to assess the short-term effects of glyphosate on algal photosynthesis.

Effects of glyphosate treatment on carbon fixation were not detected in samples from any pond at concentrations less than about 0.89 mg/L. Carbon fixation occurred at the highest tested concentration. Estimate EC 50 values for Pine, Hike and Birch Ponds ranged from 35.4 to 69.7 mg/L glyphosate. Based on the estimated glyphosate concentration which could result from a hypothetical application of 2.5 L/ha Roundup to the study ponds (0.06-0.10 mg/L), no immediate effects of herbicide treatment on periphytic algal photosynthesis are predicted.

REPORT 87-4 Beck, A. E. 1987. Glyphosate residues in surface water following initial MANFOR Ltd. field trials, 1985. Environmental Management Services Branch. Water Standards and Studies. 31pp.

SUMMARY

Forestry management personnel of Manfor Ltd. conducted experimental field trials of the herbicide Roundup(R) during 1985. The trials, conducted at three sites near The Pas, were carried out to assess the efficacy of Roundup(R) for control of weed tree and shrub species on forestry plantations. Rates of aerial application were 1.08, 1.44 and 1.80 kg of active ingredient per hectare. Glyphosate is the active ingredient in Roundup(R).

A meager literature pertaining to the activity of glyphosate in aquatic systems, the absence of locally generated data and strong concerns among area residents, prompted Manfor Ltd. to enlist the aid of Manitoba Environmental Management Division for monitoring environmental impacts. The objective of the present study was to examine glyphosate residues in surface waters following application to experimental spray blocks. Issues examined included quantitation of residues, persistence and transport of residues from the target area. Utilization of external analytical facilities also required assessment of analytical capabilities.

Residues of glyphosate and AMPA, the major metabolite of glyphosate, were analyzed. The analytical detection limits, calculated from a series of blanks were 2.2 µg/L for glyphosate and

9.05 µg/L for AMPA. Mean recovery rates for spiked samples was 115% for glyphosate residues. Recovery rates for AMPA residues could not be independently assessed because of a lack of stock chemical. These analytical capabilities were considered adequate for the purposes of the present study.

Quantitation of residues and assessment of persistence were hampered by limited ponded water located within the confines of the experimental spray blocks. However, maximum glyphosate residues of 1088 µg/L were detected within one pond less than 1-1/2 hours after spray. This value corresponded reasonably well to the 1.08 Kg/ha rate of application for the site. Maximum AMPA residues of 10.9 µg/L were detected at the same site 5 days after spray. Neither glyphosate nor AMPA residues were detected 30 days after spray.

Glyphosate residues were observed to dissipate much more rapidly than had been indicated by most literature references. A half-life of less then 24 hours was indicated for glyphosate applied aerially under local conditions. Minimal and infrequent detections of AMPA precluded definition of dissipation rates for this metabolite.

Transport of glyphosate and AMPA residues to aquatic systems outside of the target area was limited to drift during and immediately following aerial application. Evidence of other transport mechanisms was not encountered at any of the 19 peripheral sampling sites.

REPORT 87-5 Beck, A. E. Recreational development capacity study of twelve lakes in the South Riding Mountain Planning District, 1985. Environmental Management Services Branch. Water Standards and Studies. 150pp.

SUMMMARY

The South Riding Mountain Planning District Board requested that recreational development capacity studies be conducted on twelve lakes located within the Planning District. The Board's goal was to develop guidelines for recreational development such that lake water quality was maintained, that the aesthetic appeal of the area was not impaired and that prospective water based recreational activities could be safely accommodated.

The study commenced in July 1985 as a joint effort between the Board and Water Standards and Studies Section of the Manitoba Department of Environment and Workplace Safety and Health. Board responsibilities included sample collection and provision of required background information. The responsibilities of Water Standards and Studies Section included sample analysis, data interpretation and report preparation. Interpretive aids and applied procedures included assessment of trophic status, identification of problem nutrients, development and validation of phosphorus budgets and calculation of cottage capacities and boat capacities.

The results obtained from seven of the lakes studied were particularly successful from the viewpoint of achieving study goals. Although considerable advances were made in understanding the limnological characteristics of the remaining five lakes, the results obtained precluded full achievment of study goals set for these waterbodies. Results and recommendations derived for each of the lakes are summarized individually.

Ditch Lake was found to be an eutrophic waterbody. The water quality was generally suitable for recreational purposes except during major algae blooms. Algae and weed growth in the lake was controlled by phosphorus availability. The phosphorus loading rate was excessive and had induced a long term deterioration in water quality. The development capacity of Ditch Lake had been exceeded by approximately 500% and this continued to exacerbate the problem of water quality deterioration. Boating capacity for the lake had also been greatly exceeded and this created a significant potential for conflict between various water based recreational activities, including the risk of a serious boating accident. It was recommended that further development not be permitted and that local authorities consider imposing restrictions on power boats. In order to decelerate water quality deterioration, it was also recommended that recreationers and local landowners be encouraged to install wastewater holding tanks and to plant tree and shrub buffer zones.

Kerr Lake was found to border on the eutrophic state. The water quality was generally suitable

for recreational purposes except during particularly severe algae blooms. Similar to Ditch Lake, phosphorus availability controlled algae and weed growth. The background phosphorus loading rate was excessive and had induced a slow deterioration in water quality. Kerr Lake had some potential to accommodate additional development without detectably affecting water quality. Thus it was recommended that future development at Kerr Lake not exceed a lake total of 33 additional cottage equivalent units. These latter were to be calculated at the rate of 1 cottage = 0.147 residences = 1.10 campsites/day use sites. Neither present utilization nor the recommended maximum allowable additional development cause the lake boating capacity to be exceeded.

Both Otter Lake and Little Jackfish Lake were found to be hyper-eutrophic. This means that the water quality generally is not considered suitable for body contact recreational purposes. Nitrogen availability controlled algae and weed growth in Little Jackfish Lake while either nitrogen or phosphorus controlled production in Otter Lake. Significant conflicts between various water based recreational activities are unlikely at present rates of utilization of these waterbodies. The data obtained during the present study was insufficient for development capacity predictive purposes. Thus it was recommended that the limnological study of Otter Lake and Little Jackfish Lake be extended for another year and that decisions affecting development proposals for these lakes be postponed until completion of the extended studies.

Sandy Lake was found to be an eutrophic lake. The water quality generally is considered suitable for recreational purposes except during major algae blooms. Phosphorus availability controlled algae and weed production in the lake. Significant conflicts between various water based recreational activities are unlikely even at the present moderate to heavy rate of utilization by boats. Similar to Otter and Little Jackfish Lakes, the data obtained was insufficient for development capacity predictive purposes. Again it was recommended that the limnological study be extended for another year and that decisions affecting development proposals be delayed until study completion.

Both Crawford Lake and Thomas Lake were found to be mesotrophic waterbodies. The water quality of each was considered suitable for recreational purposes. Either nitrogen or phosphorus availability could alternate as the nutrient controlling algae and weed production on these lakes. The phosphorus loading rates to both lakes were excessive, with that of Crawford Lake being particularly high. Due to background phosphorus loadings, the water quality of both lakes was expected to continue to slowly deteriorate over time. The current degree of development at Thomas Lake approximates capacity and it was recommended that further development not be permitted. However, Crawford Lake had some potential to accommodate additional development without detectably affecting water quality. Thus it was recommended that future development at Crawford Lake not exceed a lake total of 19 additional cottage equivalents. These latter were to be calculated at the rate of 1 cottage = 0.147 residences = 1.46 campsites/day use sites. It was also recommended that Crawford Lake landowners and recreationers be encouraged to establish tree and shrub buffer zones around the lake to reduce the excessive rate of phosphorus loading.

Czornyj Lake was found to be eutrophic and the water quality was generally considered suitable for recreational purposes except during major algae blooms. Phosphorus availability controlled algae and weed growth in the lake. The phosphorus loading rate was excessive and had induced a long term deterioration in water quality. Czornyj Lake also had some potential to accommodate additional development without detectably affecting water quality. Thus it was recommended that future development not exceed a lake total of 11 additional cottage equivalent units. These latter were to be calculated at the rate of 1 cottage = 0.147 residences = 1.10 campsites/day use sites.

Both Dummy Lake and Stewart Lake were found to border on the eutrophic state. The water quality of each lake was generally considered suitable for recreational purposes except during particularly severe algae blooms. Either nitrogen or phosphorus availability could limit production in these lakes. Significant conflicts between various water based recreational activities are unlikely at present rates of utilization by boats. Similar to Otter, Little Jackfish and Sandy lakes, the data obtained for Dummy Lake and Stewart Lake was

insufficient for development capacity predictive purposes. Thus it was recommended that the limnological studies of these waterbodies be extended for another year and that decisions affecting development proposals for Dummy and Stewart lakes be postponed until completion of the extended studies.

Imrie Lake was also found to border on the eutrophic state. The water quality was generally considered suitable for recreational purposes except during particularly severe algae blooms. Phosphorus availability controlled production in the lake. The phosphorus loading rate was on the verge of becoming excessive but had not yet induced severe water quality deterioration. The water quality is particularly susceptible to land surface disruption within the immediate watershed because of the present finely balanced status of the lake. Nevertheless, Imrie Lake had some potential to accommodate additional development without detectably affecting water quality. Thus it was recommended that future development not exceed a lake total of 28 additional cottage equivalent units. These units were to be calculated at the rate of 1 cottage = 0.147 residences = 1.12 campsite/day use site. Due to the sensitivity of the lake, it was also recommended that proponents of future developments be encouraged to exercise extreme care in the matter of land surface disruption.

Seech Lake was a mesotrophic waterbody. Accordingly, the water quality was considered suitable for recreational purposes. Similar to the other mesotrophic lakes, either nitrogen or phosphorus availability could limit algae and weed production. Due to background phosphorus loading rates, the water quality was expected to continue to slowly deteriorate over time. The boat capacity of the lake has been substantially exceeded and this currently restricts further development. Seech Lake has the potential to accommodate some additional development without inducing detectable water quality deterioration providing that allowance is made for the excessive boating potential. Thus it was recommended that future development not exceed a lake total of 26 additional cottage equivalent units. These units were to be calculated at the rate of 1 cottage = 0.147 residences = 0 campsites/day use sites. In

order to reduce the significant risk of a serious boating accident or other water based recreational conflict, it was also recommended that local authorities consider prohibiting the use of motorized craft in the lake.

REPORT 87-6 Beck, A. E. Reed Lake water quality near Spruce Point Mine, 1983. Environmental Management Services Branch. Water Standards and Studies. 76pp.

SUMMARY

Hudson Bay Mining and Smelting Company, Ltd. completed development of the Spruce Point Mine in 1981. The mine site is located on a point projecting from the south shore of Reed Lake. Reed Lake is the largest waterbody in the Grass River Provincial Park and is highly valued for its exceptional water quality. Development of the mine aroused concern that Reed Lake water quality might be jeopardized.

The present study was conducted in August, 1983. Its purpose was to develop a baseline of data which could be used to readily and speedily detect anthropogenic changes in water quality. The delineation of baseline included data on water physicochemistry, metal concentrations in sediments and metal residues in fish. Comparisons were made to other appropriate lakes in order to determine whether or not the data base derived was indicative of natural background.

The water physicochemistry was typical for lakes of the area which straddle the Precambrian - Ordovician geological boundary. Waters were moderately alkaline but had little buffering capacity. Toxic metals were not detected in the water column. Metals were present in sediments at atypically low concentrations. This was attributed to the sandy nature of the sediments. Metal residues in fish were generally low, but still within the range of natural background for the area.

It was concluded that the water physicochemistry, sediment metal concentrations and metal residues in fish evidenced no anthropogenic impact. Therefore, it was concluded that the data obtained was representative of natural background and could be used as baseline reference for subsequent impact assessment.

REPORT ____ Therrien-Richards, S. and D. A. Williamson. 1987. Contamination by pesticides of the La Salle and Assiniboine Rivers, Manitoba, Canada. Environment Canada and Manitoba Environment and Workplace Safety and Health. W&NR 87/88-CP(EP)-1. 54pp.

SUMMARY

The La Salle River is located within an intensively farmed fertile basin in south-central Manitoba. The natural flow in this stream is being augmented with water pumped from the Assiniboine River in an attempt to provide an adequate supply for domestic consumption, livestock watering and irrigation purposes. Concerns with regard to the presence of agricultural pesticides in this stream led to the initiation of this investigation. Water samples were collected from seven locations on the La Salle River and from two sites on the Assiniboine River once per month from August to December, 1984. Representative forage fish. aquatic macrophyte and bottom sediment samples were collected on one occasion in August, 1984. All samples were analysed for bromoxynil, 2,4-D, dicamba, diclofop-methyl, MCPA, triallate and trifluralin. Dicamba, bromoxynil, diclofop-methyl and 2,4-D were quantified in water samples collected from the La Salle River at concentrations ranging from 0.20 to 3.98 µg/L. These concentrations do not pose a significant threat to humans, the data is inadequate to determine the effects to aquatic organisms. Trifluralin and triallate were not detected in the water column but were quantified in forage fish and bottom sediment samples collected from both the La Salle and Assiniboine rivers, suggesting that even at low levels, these pesticides bioconcentrate in the biota. MCPA was not detected in any medium. These agricultural pesticides were not detected in aquatic macrophytes.

JOURNAL PAPERS

Sekla, L., D. Williamson, C. Greensmith, G. Balacko, D. Brown and W. Stackiw. 1987. Bacteriological characteristics of fifteen freshwater beaches in Manitoba. Can. Jour. Public Health 78:181-184.

ABSTRACT:

During the summer of 1984 and 1985, a total of 6680 samples of lake water were collected from 15 of the most popular beaches in Manitoba and tested for faecal coliforms, enterococci and Escherichia coli. The 30 day maximum geometric mean of 200 faecal coliforms per 100 mL of water recommended as the acceptable maximum limit in the 1983 Guidelines for Canadian Recreational Water for bather protection was achieved by beaches in all three geographic regions. The United States Environmental Protection Agency (USEPA) criterion of 126 Escherichia coli per 100 mL of water was satisfied by the beaches in the Whiteshell area and the east side of Lake Winnipeg, but not by beaches on the west side of Lake Winnipeg. The USEPA criterion of 33 enterococci per 100 mL, as well as the enterococcus criteria proposed for Manitoba were not met by most beaches in all three regions. Before recommending changes to the national guidelines for recreational water quality (i.e. adding enterococci criteria), it is important to document an association between illness and counts of a specific indicator bacteria, standardize the test procedures for this bacteria and to agree on the bacterial counts that would relate to an acceptable risk to bathers.

PUBLISHED PROCEEDINGS

Chacko, V. and D. A. Williamson. 1986. Water quality concerns with sediment. In. Proceedings of The Manitoba Sediment Issues Workshop. Environment Canada. IWD-WNR(M)-WRB-SS-87-1.

Playle, R. C., D. A. Williamson and D. A. Duncan. 1987. Water chemistry changes following diversion, impoundment and hydroelectric development in northern Manitoba. In. Proceedings of the Symposium on Interbasin Transfer of Water: Impacts and Research Needs for Canada. Canadian Water Resources Association.

PRESENTED PAPERS

Brown, D. J. Introduction to Limnology. Paper presented at the 33rd Annual Water and Waste School, Winnipeg, Manitoba. February 16-20, 1987.

Brown, D. J. Manitoba land use impact on water quality. Paper presented to the Fifth Annual Red River Valley International Land and Water Summit Conference, Winnipeg, Manitoba. November 19-20, 1987.

Williamson, D. A. Manitoba water quality objectives. Paper presented at the 33rd Annual Water and Waste School, Winnipeg, Manitoba. February 16-20, 1987.

Williamson, D. A. and S. Therrien-Richards. Contamination by pesticides of the La Salle and Assiniboine Rivers, Manitoba, Canada. Paper presented at the 5th Biennial Plans Aquatic Research Conference. August 24-26, 1987, Winnipeg, Manitoba.